Student Worksheet 1: Solar System Catalog

Name ______________________________ Date __________

A catalog allows you to learn many things about the inventory of a store. For example, you can learn what kinds of items they have and at what price. Here's a novel idea—imagine you manage a store called the Solar System. Your job is to create a catalog of the Solar System so we can determine what kinds of objects are contained within it.

Directions:

1. You will need to create a cover page. It must contain your name and a title for your catalog.

2. You will need to research the different components of the Solar System, including:
   - The Sun
   - Planets
   - Moons
   - Comets
   - Asteroids and Meteoroids
   - Dwarf Planets
   - Kuiper Belt Objects

3. One page in your catalog should be dedicated to each component. Each page should contain the following for the component addressed:
   - Component's name
   - Description of component
   - Average size or size range
   - Composition
   - General location in the Solar System

   An example of the component including a picture—your picture may be a drawn image, a magazine clipping, or printed out from the internet.

4. Use the supplies your teacher makes available to create a catalog that is full of accurate information, as well as neat and creative.

Question

Answer the following question after you have shared your catalog with the class:
Is our Solar System the only solar system, or one of many? Support your answer with information from your research and the class discussion.

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Student Worksheet 2: What a Wonderful World

Name ______________________________ Date ____________

Travel agents help people plan vacations to exotic destinations like Hawaii, Fiji, and Finland. However, travel agents of the future may have to help people plan vacations to other spots like Venus, Jupiter, or Mars! Your job is to create a futuristic travel brochure for a planet in the Solar System. Follow the directions below to get started.

Directions:

1. First, you will need to research your planet. Your brochure should contain the following:

- Planet's name
- A picture of the planet
- Nature of planet's atmosphere and climate
- Planet composition—What is it made of?
- Fast Facts
  - The number of the planet in the order of the distance from the Sun
  - Distance from the Sun
  - Length of day
  - Length of year
  - Number of moons
  - Presence of rings
  - Diameter of planet—How big is it compared to Earth?
- Three possible day-long trips on your planet—As a travel agent you should plan your trips based on what is interesting about your planet. For instance, are their any interesting surface features, moons, rings, etc.?
- Three suggested items to bring—What is the atmosphere on your planet like? Will you need an oxygen tank? What is the temperature like? Should you bring a bathing suit, sweater, or both?

2. You will be given supplies and a sheet of 11" x 17" paper to create your brochure. You may design your brochure any way you see fit. Remember to include all of the required information while making it neat and creative.

3. Prepare a short 3-5 minute presentation to the class describing your planet. Use your brochure as a visual aid.

Student Worksheet 2: Voyage of Discovery

Name ______________________________ Date __________

1. Match the sizes of the items that your teacher provides to the size of the planets on the cards below. Tape the appropriate size item on top of each of the planets using transparent tape. Cut out the cards below and tape each of them to a separate piece of poster board.
2. Blow up a yellow balloon to approximately 14 cm diameter to represent the Sun. Tape the balloon to another piece of poster board.
3. As directed by your teacher, use masking tape to attach a stick or stake to each piece of poster board, or fold your poster board in half to create tent cards.
4. Use a thick marker and write the name of the planet (or Sun) on the appropriate piece of poster board. Use big letters so that the name of the planet or Sun can be seen from a distance. When finished, you will have 10 poster boards containing your model planets and Sun.

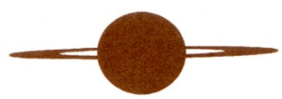
MERCURY

VENUS

EARTH

MARS

JUPITER



SATURN

URANUS

NEPTUNE

PLUTO

JOURNEY through the UNIVERSE

Model Distances Chart

	Paces (or meters) between models	Total paces (in meters) from model Sun to each model planet	Distance from the Sun to each planet in meters
Sun to Mercury	6 meters	6 meters	60,000,000,000
Mercury to Venus	5 meters	11 meters	110,000,000,000
Venus to Earth	4 meters	15 meters	150,000,000,000
Earth to Mars	8 meters	23 meters	230,000,000,000
Mars to Jupiter	55 meters	78 meters	780,000,000,000
Jupiter to Saturn	65 meters	143 meters	1,430,000,000,000
Saturn to Uranus	144 meters	287 meters	2,870,000,000,000
Uranus to Neptune	163 meters	450 meters	4,500,000,000,000
Neptune to Pluto	142 meters	592 meters	5,920,000,000,000

Student Worksheet 1
Creating Craters

Name ______________________________ Date __________

Student Materials (per pair of students)

- 1 pie pan
- Two pebbles or marbles of different sizes
- Scale
- Bag of flour or box of cornstarch
- Sifter
- Metric ruler
- Newspaper
- Powdered cocoa
- Meter stick
- Calculator (optional)

Directions

1. Use the scale to measure the mass of your two impactors (pebble or marble) and record the data in the Impact Table on the next page.

2. Cover your area of the floor with newspaper.

3. Fill a pie pan with a thick layer of flour. Smooth out the flour so that it is as flat as possible.

4. Cover the top of the flour with a light dusting of cocoa. Use a sifter if you have one available.

5. Place the pie pan on the floor or on the ground.

6. Place one end of the meter stick on the floor next to the pan and measure 30 cm above the pan.

7. Drop one of your impactors into the pan from the 30 cm height.

8. Remove the impactor, and repeat steps 5 and 6 with a different size impactor, creating a second impact site in the pan so that it is not too close to the first impact. Remove the impactor, and draw a picture in the Impact Table on the following page.

9. Measure the size of your impact craters and record their diameters in the Impact Table.

10. Smooth the flour, sift on a now layer of cocoa, and repeat steps 5-7 for impacts from heights of 20 cm and 10 cm. Calculate the amount of energy for each impact.

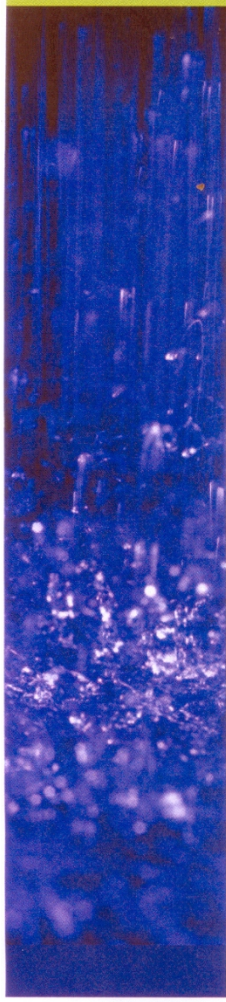
PRINT

ACT OUT THE SCIENCE

Whole Group Mime Activity: Movement Integration Mediating Experience

The Story of H_2O

Narrative	Movement	Meaning
You've probably heard that water and ice are made of H_2O. What does this really mean? Let's explore this *mimediately*. Everyone stand up. Let's see if we can figure this out together.	Have everyone stand up in an open area. Make sure everyone has plenty of room to move without bumping into anyone or anything.	We are going to use the hands and then the whole body to create an experiential model of H_20.
First, put up your hands, shake them out. Roll your hands into a fist, and then unroll. Good.		
Okay, now we are going to make models of molecules of water—out of ourselves! So, what is H_2O? First, let's explore what the H means: hydrogen. What's hydrogen? It's a tiny atom with a proton and an electron. Hydrogen is what stars are made of. And it's mostly what we are made of. Hydrogen is in a lot of the foods we eat: have you ever heard of proteins and carbo*hydrates*? Got hydrogen? When we eat proteins and carbohydrates and when we drink water, we're *hydrogenating* ourselves!	Invite students to mention and mime different protein and carbohydrate foods that have hydrogen as part of their structure.	This illustrates H_2O in a dynamic, kinesthetic way, comparable to a graphic illustration. This sequence builds a precursor understanding of atoms and molecules.
So let's start making a model of Hydrogen. Let one hand roll into a fist. We'll call this fist a powerfully positive proton. It is the center, or the *nucleus*, of an atom of hydrogen.	Have everyone form one fist, in the air, to show a proton.	



Narrative	Movement	Meaning
Now, let the other hand, with its fingers opening and closing and zipping around, sometimes in close to your powerfully positive proton, sometimes jumping about. This represents an energetic electron cloud.	One hand remains playing the part of the powerfully positive proton, as the other hand moves around as the energetic (and negatively-charged) electron cloud.	
If you could move your hand as fast as an electron, it would seem to be every-where all at once as far as it could reach.		
If a proton were really as big as your fist, your arm would have to be 100 to 200 yards long. We'd have to reach from here to …select a familiar spot to make this point… and move so fast as to be everywhere in every direction filling up that space.	Let everyone stretch their arms, imagining that they are getting longer and longer.	Scale: if you were standing on the pitcher's mound, your arm would have to reach to the outer bleachers and race around in all direc-tions to fill up the volume of space defined by the elec-tron cloud
Together, your powerfully positive proton and your energetic electron cloud make up an atom of Hydro-gen. When two of them join up with an oxygen atom, it makes H_2O. Got water?	Together, the fist and the rapidly moving open hand, represent an **H atom**.	An H atom—with proton nucleus and electron cloud.
Let's make a new model to fit this all together: imagine now, that your head is an atom of oxygen, O, and each of your hands, a hydrogen atom ready to connect, forming a covalent bond, which you can show as your arms. Hey, they're already connected!	Take a moment to shift the scene from the two hands showing the H atomic struc-ture to the H_2O: the head is now the O atom; the two fists are the two H atoms. The arms represent the covalent bond that holds the H close to the O.	

Narrative	Movement	Meaning
Oxygen attracts two H atoms to make a triangular shape. Stretch your arms as if you were about to give a bear hug (~104°). Notice that it's a little wider than if we were making the shape of the corner of a square (90°).	The two arms become the two H atoms that seek to join the O	This forms a covalent bond, a sharing of electron cloud space.
Now each of us is a water molecule. H– shake your fist—2– shake both your fists—O– bob your head. Hey, look, we're *bobbled water!*		
At room temperature, we all just slosh and bobble around as liquid water, but if it gets colder… down close to within 4°C of freezing, we start moving closer together, more densely packed—but just as we reach freezing, we water molecules expand and connect!		These connections are *hydrogen bonds.* This also anticipates understanding why ice floats
Slightly widen your bear hug angle to ~109° and you'll notice that we just fit six of us to form a ring, hand to shoulder—this shape is a six-sided hexagon, and we are now frozen ice crystals!	The precise difference between 104° and 109° angle is not so important. But it is important to understand that the slightly larger bear hug makes a difference—between water and ice.	The difference between 104° and 109° is very slight, yet the distinction is critical because it helps explain structurally why ice is less dense than water.

Note: The diagram on page 13 will help you guide the 'frozen H_2O molecules' into a hexagonal arrangement.

WORKSHEET 1

Record observations of UV beads in film canisters.

CANISTER	START COLOR	END COLOR
Canister 1. (control) on the ground with nothing over it	____________	____________
Canister 2. covered with a white piece of cloth	____________	____________
Canister 3. covered with a black piece of cloth	____________	____________
Canister 4. covered with sunglasses	____________	____________
Canister 5. covered with a baseball cap	____________	____________
Canister 6. filled with water	____________	____________
Canister 7. covered with plastic wrap	____________	____________
Canister 8. covered with plastic wrap and a coat of sunscreen (spf 5 or 8)	____________	____________
Canister 9. covered with plastic wrap and a coat of sunscreen (spf 30)	____________	____________

Mission Design

Your team: ______________________________

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Date: ____________

Introduction

Your team will design a spacecraft mission to explore another world in the Solar System. You must decide which world you want to explore, what you want to learn about your target world, and how you want to accomplish your mission. It can be tricky because space exploration is expensive and hazardous. Along the way, you may need to re-examine your mission goals based on available funding and other constraints. At the end, you must prepare a comprehensive proposal that you could submit to NASA. In your proposal, you must make a convincing argument why your mission should be selected for funding. Good luck!

1. Choose a World to Explore

Within your team, choose a world you would like to explore. You can use the Mission Log to find an interesting world to examine. If you are operating with a limited budget, you may also want to look at Table S1 in the Mission Cost List to help decide which world to investigate, since some worlds are more expensive to explore than others.

Your target world: ______________________________

A) The basic cost to explore this world (table S1, Mission Cost List): ____________

This includes the approximate cost associated with building the spacecraft, sending it on the journey to explore your target world, communicating with the spacecraft, as well as receiving and analyzing the data.

2. Mission Goals

Examine the Mission Log to see what is known about this world already. Think of three questions which previous missions have not found out, or additional questions which the previous explorations may have raised and which your mission might be able to answer. These are your mission goals:

Mission Goal 1:

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Mission Goal 2:

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Mission Goal 3:

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3. Type of Mission

Now that you understand what your mission needs to accomplish, you can decide what type of mission (fly-by, orbiter or lander) will best help you meet your goals. Remember the pros and cons of each type of mission, and what you can learn through the different methods. You may also want to check the costs in Table S2 in the Mission Cost List, since some types of missions cost more than others. Also, the more complicated the mission you want to perform, the more chances there are for something to go wrong. The possibility of failure can be estimated by using a risk factor: the higher the factor, the riskier the mission.

Your mission will be (circle one): Fly-by Orbiter Lander

Because:

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____

B) Additional cost for this mission (Table S2, Mission Cost List): ____________________

B1) Risk Factor (Table S2, Mission Cost List): ____________________________________

4. Length of Mission

Once you have selected the type of mission, you need to consider the length of the mission. The longer the mission, the greater the cost due to:

- Communications with ground control on Earth to operate the spacecraft and transmit data for analysis;
- Spacecraft operations to make course corrections that may be necessary, to maintain the well-being of the spacecraft, and to respond to any emergencies that may arise;
- Data analysis by scientists on Earth; the more data that is gathered, the more time (or more scientists) are needed for analysis; even after the spacecraft has ceased functioning, there usually is additional time scheduled for data analysis;
- Extra fuel that may be necessary to make course corrections, etc.

The length of the mission depends on the time it takes to travel to the target world, as well as the time spent observing the world. The cost of traveling to the world was considered in cost item A. You must now decide how long your spacecraft will operate once it arrives to your target world. See Table S3 in the Mission Cost List to determine how much the length of your mission affects your plan. A longer mission also means that there are more chances to fail before meeting all mission goals. Mark the appropriate risk factor below, as well.

Time spent to explore the world: ________________________________ years

C) Additional cost for the length of the mission (Table S3, Mission Cost List): ____________

C1) Risk Factor (Table S3, Mission Cost List): ________________________________

5. Payload

Now you have to decide which instruments to include in your spacecraft to help you accomplish your mission goals. See Table S4 in the Mission Cost List for the different kinds of instruments available for your spacecraft. You can pick up to five instruments. Explain why the instrument is necessary to meet your mission goals.

MISSION COST LIST

Table S1. The basic cost to explore different worlds.

Destination	Cost
Mercury	$200 million
Venus	$100 million
Mars and/or its moons; asteroids and comets in the inner Solar System	$100 million
Jupiter and/or its moons	$300 million
Saturn and/or its moons	$350 million
Uranus and/or its moons	$400 million
Neptune and/or its moons	$450 million
Pluto, other dwarf planets, Kuiper Belt Objects, and comets far from the Sun	$500 million

Table S2. Considerations associated with different types of missions.

Type of Mission	Additional Cost	Risk Factor
Fly-by	(none)	1
Orbiter	$100 million	2
Lander	$200 million	5

Table S3: Considerations associated with missions of different length.

Time Spent Exploring the World (in addition to the time it takes to travel there)	Additional Cost	Risk Factor
1 year	(none)	1
2 years	$1 million	1
5 years	$5 million	2
10 years	$10 million	3